

## STOMOXYS CALCITRANS LINN.

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*Stomoxys calcitrans* Linn. has often been suspected of being an agent in the transmission of disease, and the recent experiments of Rosenau, Anderson and Frost seem to show conclusively that this insect can, and may, transmit Acute Poliomyelitis in animals—monkeys were used.

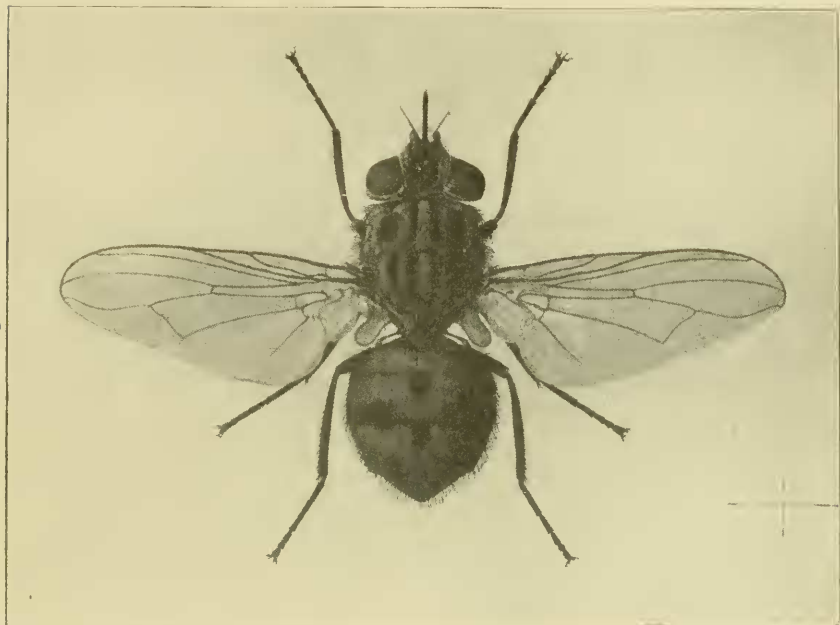


Fig. 1. *Stomoxys calcitrans* Linn. ♀. (After Austen.)

It is not said that *Stomoxys calcitrans* is the actual carrier of Infantile Paralysis in Nature, but its common occurrence in localities where the disease is most prevalent, and its ability to transmit the disease from sick to healthy animals, makes further study of the species desirable. Considerable mention has been made of this fly in the entomological literature of the last fifty years, chiefly in relation to its occurrence in stables, and various methods have been recommended for its destruc-

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\*This work was undertaken in connection with experimental work now being conducted by the Ohio State Board of Health, and the blocks used for the illustrations are the property of that Board.

tion, but, as far as I could ascertain, no work has been done in this country on its mouthparts and internal anatomy. Four papers in England and one of minor importance in France, which apply to this genus, if not to this particular species, are included in the Bibliography.

Facts relating to its life-history have been recorded by Packard and others, and Prof. James S. Hine of Ohio State University is at present working on this side of the subject. The writer made observations on its life-history in South Africa, and conducted feeding experiments in connection with the transmission of a *Trypanosoma* disease from Portuguese East Africa. When on this work it was noticed that very few *Stomoxys calcitrans* larvæ could be obtained from old, heating manure, but that, as a rule, perfectly fresh horse dung was chosen for oviposition. Where this was collected into heaps with stable refuse, and generated heat, nearly all the larvæ found in it were of *Musca domestica*. In rooms where food was kept the majority of flies were of the latter species, *Stomoxys calcitrans* being most prevalent in such places on dull, cool days. Counts were made of flies caught in the windows of two rooms of the Government Experiment Station at Rosebank, near Cape Town in 1910. In room A, the laboratory, over 40% of the flies caught in a week were *Stomoxys calcitrans*, while in room B, one of the living rooms, *Musca domestica*, comprised 93% of the flies caught, while *Stomoxys calcitrans* was rarely taken, representing less than 3% of the whole. The distance between the two rooms was approximately 35 feet. The three flies most common in houses, all of which have a very wide distribution, being almost universal, are *Musca domestica*, the House-Fly, *Homalomyia canicularis*, the Lesser House-Fly, and *Stomoxys calcitrans*, The Stable-Fly. The particulars given with the accompanying figures in Plate XXXIII will suffice for their identification in the various stages.

*Musca domestica* Linn. The House-Fly.

*Egg*: About 1 mm. long, elongate, cylindrical, oval, rather more pointed at the anterior end, dull chalky white in color. About 100 to 150 eggs laid in a mass in crevices in house refuse or accumulations of horse manure. Eggs hatch under favorable conditions in 8 to 24 hours.

*Larva*: 7 to 10 mm. long when full grown, greasy white in general color, except for the darker color of the contents of the alimentary tract. This larva can be distinguished from others by the shape and size of the plates which surround the posterior respiratory apertures.

These are situated on the broad end of the body and are close together, comparatively large, and circular except for the inside edges, which are straight. Under favorable conditions the larva is full grown and pupates in from 4 to 7 days. (See Fig. 2).

*Pupa:* Yellowish brown to dark reddish brown, barrel shaped, but tapering slightly towards the anterior end, 6 to 8 mm. long. (See Fig. 3.) Under most favorable conditions of temperature and humidity the pupal stage lasts 3 to 5 days.

*Adult:* The normal length is about 6 or 7 mm., mouse gray in color, while the thorax has four black, longitudinal stripes, which are usually most sharply defined in front. It may be noticed that the compound eyes more nearly meet on top of the head in the male than in the female. The proboscis, at rest, is not visible from above. The end of the 4th longitudinal vein bends sharply up so as to nearly join the vein above it. (See Fig. 1.) Females hibernate in winter. The House-Fly cannot bite and does not suck blood.

*Homalomyia canicularis*, Linn. The Lesser House-Fly.

*Egg:* This has not been studied by the writer but it is reported to be deposited in decaying animal and vegetable matter.

*Larva:* About 8 mm. long when full grown, brownish yellow in color and somewhat abruptly narrowed in front. This larva may readily be distinguished from that of *Musca domestica* or of *Stomoxys calcitrans* by the presence of spines shown in Fig. 5.

*Pupa:* The bristles of the last larval stage still persist in the pupa as does also the brownish coloration. The case is, however, somewhat shorter than the extended larva. (See Fig. 6.)

*Adult:* Normal length about 6 mm., but this fly is much more slender than the common house-fly. The thorax is blackish or dull grey, but the distinct longitudinal stripes are not noticeable in the ♂.

Front of head shining white in the ♂, while that of the ♀ is darkish grey. Width of vertex in the ♂ is one-seventh; in the ♀ one-third the total width of the head. *The proboscis is not visible from above.* End of 4th longitudinal vein not bent up towards the vein above but parallel to it. When this fly is at rest the tips of the wings are nearer together than in *Musca domestica*. This adds to the narrower and smaller appearance of the insect, and no doubt accounts, in some degree, for the common, but erroneous idea that these are young house-flies. Like the house-fly this species cannot bite and does not suck blood.

*Stomoxys calcitrans* Linn. The Stable Fly.

*Egg:* About 1 mm. long, white, elongate and banana-like in shape. One side straight, with a deep groove, the other curved. Laid in small masses of 40 to 70, in accumulation of moist and fermenting vegetable matter (straw, etc.), or in fresh horse manure. At favorable temperature the eggs hatch in 2 to 4 days.

*Larva:* Length when full grown about 10 mm., very similar in appearance and color to the larva of *Musca domestica*, but may be readily distinguished by the plates of the respiratory tubes which are dis-

tinely smaller, circular, and from 4 to 6 times as far apart. (See Fig. 8.) Larval stage usually lasts 15 to 21 days, but may be extended under unfavorable conditions up to 80 days.

*Pupa:* Bright reddish brown to chestnut brown in color, and normally 6 mm. long; precisely similar to that of *Musca domestica* from which it may be distinguished by the plates in the same manner as the larva. In summer the adults usually emerge in 9 to 13 days after pupation. (See Fig. 9.)

*Adult:* Normal length about 7 mm., rather more robust in shape than either of the foregoing, darkish grey. Thorax with 4 conspicuous blackish longitudinal stripes. Abdomen without ochraceous-buff patches but dotted with clove-brown, the spots usually more conspicuous in the ♀. Vertex  $\frac{1}{4}$  in ♂, and  $\frac{1}{3}$  in ♀ the width of the whole head. Proboscis shining black, projecting horizontally in front of the head, *visible from above* when not feeding. The end of the 4th longitudinal vein bent up, but not so much as in *Musca domestica*. (See Fig. 7.) A biting fly, *both sexes suck blood* from human beings as well as from cattle, horses, etc. Common about farmyards and stables, and common in houses near such places, especially on dull days. This accounts for the old saying in the country districts, that it is a sign of rain when the flies bite.

#### *External Mouth Parts.*

Unlike some of the other well known Blood-Sucking Diptera the male of this species feeds also on blood, and I have been unable to determine any difference between the mouth parts of the two sexes of *Stomoxys calcitrans*. The following description will therefore apply equally well to male or female. The external mouth-parts consist of maxillary palpi and the proboscis. (Plate XXXIV, Fig. 1. *mxp.* and *pr.*) Maxillæ proper and mandibles are not found, the proboscis consisting of the labrum, hypopharynx and the labium.

The *maxillary palpi* consist of a single segment and are approximately one-fourth the length of the proboscis.

The *proboscis*, in a resting position, extends horizontally below the head and may be plainly seen projecting for about one-third of its length in front of the head. In this position its base is closely applied to the lower part of the head in the ventral groove, but when extended it will be observed that its attachment to the lower chitinous skeleton is membranous, except for the two strong apodemes. (*ap.* in Figs. 1, 2 and 4, Plate XXXIV.)

The *maxillary palpi* are attached to this membranous cone, and do not, in any part, enclose the proboscis. The proboscis is

somewhat longer than the height of the head, distinctly thickened, in the basal half, black, shining, and practically smooth.

The *labium*, or lower lip, is the strong black part referred to, and this constitutes the sheath for the labrum and hypopharynx. The labium consists of three segments. (Plate XXXIV, Fig. 1, *i*, *ii*, *iii*). Segment *i* is eight to ten times the length of the other two together. Segment *ii* is very small and inconspicuous, and segment *iii* is composed of the labella. Throughout the whole length of the labium is the dorsal groove, in which lie the labrum and hypopharynx. This dorsal groove is deep in the basal part and becomes gradually more and more shallow distally. Near the extreme base it is practically closed above by the overlapping of the dorsal margins of the labium. (Plate XXXIV, Fig. 3.)

The outer chitinous walls of the labium are comparatively thin but very hard, while the interior is completely filled by muscles and tracheæ. (Plate XXXIV, Fig. 3 *mc.* and *tr.*)

Segment *ii* of the labium, as has been said, is very small, and appears as a small section of chitin in the joint between *i* and *iii*. Segment *iii* is composed of the labella, fitting together as one might place the palms of the hands together with the fingers pointing forward. Around the margins of the labella, under low power, smaller and larger hair-like processes may be seen projecting, while if a labellum be removed and its inner surface examined under the microscope its structure will be found to be elaborate and interesting.

Figure 5 shows the inner surface of the right labellum, with its lower or ventral wall at *vw*, and the dorsal margin at *dm*. It will be seen that there are five strong chitinous teeth, *ct.*, and a series of chitinous blades, *cb.*, which are more delicate. In addition to these there are a number of longer or shorter setæ on the distal and ventral margins.

The *Labrum* (of Hansen) or upper lip, (*lb*, Figs. 2, 3 and 4) (=labrum-epipharynx of Newstead) reaches nearly to the base of the labella. Its shape in section is readily seen from Figure 3, *lb.*, where it will be noticed that its lateral margins are incurved below to form a definite tube with a rather broad slit. When feeding the tube is completed by the hypopharynx. (*hp.*, in Figs. 2, 3 and 4). The labrum is thickened at the base, is somewhat strongly chitinised, and has a sharp, flattened, tri-



angular, and highly chitinized point. At intervals along the inner surface, are sense organs, each with a short clear hair.

The *Hypopharynx* is as long as the labrum, and consists, until its distal end is neared, of a tube. (Fig. 3, *hp.*) The apical part, however, is flattened and membranous, and quite unsuited for piercing.

#### *Method of Feeding.*

When about to feed *Stomoxys calcitrans* raises the body somewhat higher than the normal position on the legs, and brings the proboscis into practically a vertical position. The posterior part of the body is, in some cases, decidedly elevated. The tip of the proboscis is in this manner brought into contact with the skin of the host and the first puncture made. This, I believe, is performed by the labella, which are slightly parted so that the chitinous teeth and blades can be brought into operation. If blood emerges from the puncture it is sucked up, but if not I imagine the labella are depressed laterally and the point of the labrum forced into the host. I have observed on several occasions, when allowing *S. calcitrans* to bite, that there is often a decided stab after the first puncture had been completed.

The saliva is conducted to the wound by means of the hypopharynx, into the base of which the salivary duct opens. (*sd.*, in Figs. 2 and 4; *sc.*, Fig. 3.)

The blood is conveyed to the pharynx by means of the tube formed by the labrum and hypopharynx combined, which is in turn enclosed by the dorsal groove of the labium.

The pharynx proper has strongly chitinised walls, and powerful muscles, which make it well adapted for sucking.

#### *Digestive System.*

The relative position of the different parts of the alimentary canal in *Stomoxys calcitrans* are shown, in diagrammatic form, in Fig. 2. Beginning with the proboscis it will be seen to consist of the following parts: *l. hp.*, the canal formed by the labrum and hypopharynx combined. *g.*, the tube leading from this canal to the pharynx proper. *ph.*, the pharynx proper. *oe.*, the oesophagus, which passes through the brain at the point indicated. *pr.*, the proventriculus, from which two ducts pass backward, viz., *d. ss.*, the duct of the sucking stomach,

and the one dorsal to this, which is the thoracic intestine. *s. st.*, the sucking stomach. *in.*, the abdominal intestine. *m. t.*, the junction of the abdominal intestine and the proctodæum, at which point the Malpighian tubes enter. *r.*, the rectum. *a.*, the anus.

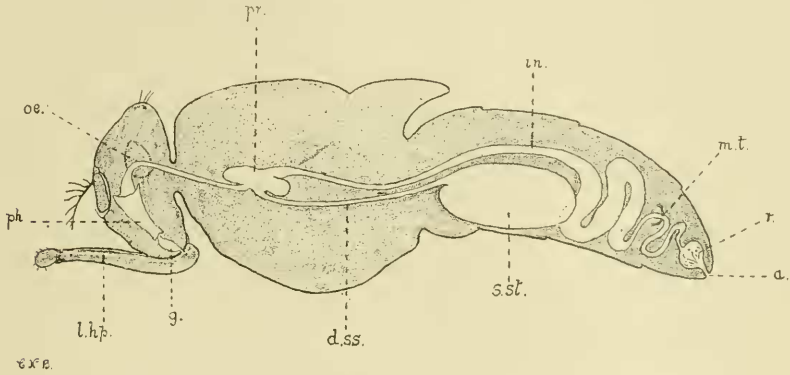


Fig. 2. *Stomoxys calcitrans* L. Semi-diagrammatic view of longitudinal section showing alimentary canal.

The food canal of the proboscis was described earlier in this paper, and this leads to a sausage-shaped tube, which has chitinous, and spirally thickened walls, and which is plainly seen in the membranous cone when the proboscis is extended for feeding. (Plate XXXIV, Figs. 2 and 4, *g.*) This, in turn, opens into the pharynx, which is roughly triangular in shape, having its upper edges drawn out into chitinous projections as muscle attachments. The oesophagus, on emerging from the pharynx, is wide and flattened, but soon becomes narrower and assumes a cylindrical form. It passes slightly forward and upward, turns abruptly backward through the brain and into the thorax, where it enters the ventral, anterior part of the proventriculus. The proventriculus is situated in the anterior third of the thorax, and, when seen from above, is a delicate white sac, circular in outline. It is roughly the shape of a mushroom, with its convex surface upward. The intestine arises from its posterior upper surface, while the oesophagus enters the ventral surface. Slightly posterior to this, again, on the ventral surface, the duct of the sucking stomach arises.

During its course through the thorax the intestine is practically of uniform thickness, but at about the point where it passes over the sucking stomach it becomes thicker, its walls,

at the same time, becoming thinner. The abdominal intestine is approximately three times the length of the fly. The thickened part, *i. e.*, that nearest the sucking stomach, is the only part coiled, and this lies in three simple, superposed coils, gradually narrowing to each end. Posterior to this the intestine continues, of practically uniform thickness, to the rectum.

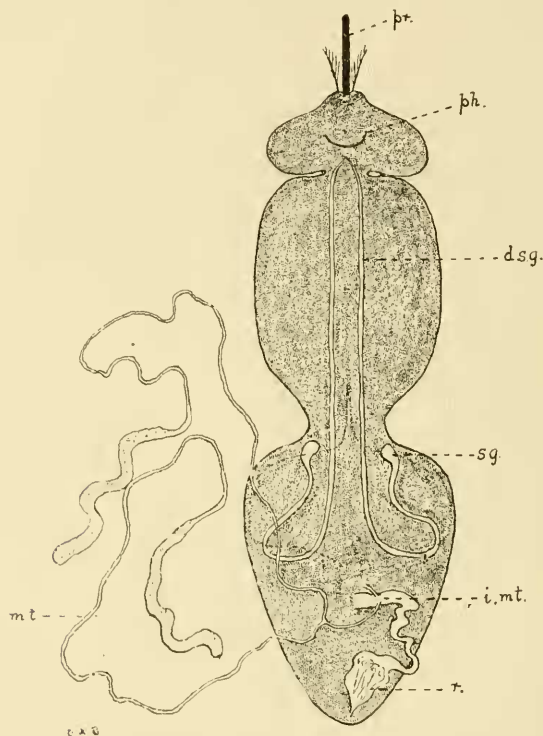


Fig. 3. *Stomoxys calcitrans* L. Salivary glands and left Malpighian tube (semi-diagrammatic).

The rectum is a transparent sac, cone-shaped, with the apex toward the anus. It contains four rectal glands, which are long and trumpet like in shape, and terminates in a narrow tube leading to the anus. The appendages of the alimentary canal are the sucking stomach, the salivary glands, and the Malpighian tubes.

The sucking stomach, when filled with blood, occupies the greater part of the abdomen, but when examined before the insect has fed, it lies in the anterior third, immediately above the salivary glands. Its walls are thin, being composed of a single layer of cells with interrupted strands of muscle fibre.



The salivary glands (Fig. 3, *s. g.*) are situated partly in the thorax, and partly in the abdomen. Their two ducts arise from the common salivary duct (Plate XXXIV, Figs. 2 and 4, *sd.*) in the head, and follow a parallel course through the thorax until the abdomen is reached. Here they become slightly wider apart, and then make a sharp turn outward and forward. Their extreme ends are slightly enlarged. Throughout their whole course they occupy a ventral position to the remainder of the alimentary canal.

The Malpighian tubes, *m. t.* in Fig. 3, are long, slender, and much coiled. They are readily seen in dissections, being easily distinguished by their opaque and yellowish appearance. They arise from the narrow, lower intestine, a single tube on each side. From each of these, in turn, two tubules branch, those of the left side only being indicated in the figure.

#### BIBLIOGRAPHY.

**Hansen, H. J.** Mouth parts of *Glossina* and *Stomoxys*, pp. 105-109 in the Monograph of Tsetse Flies by E. E. Austin, London, 1903.

**Tulloch, F. M. G.** The Internal Anatomy of *Stomoxys*. Proc. Roy. Soc. Lond. Ser. B., Vol. 77. 1905-6, pp. 523-531. Also in Jour. Army Med. Corps, Lond. Vol. 7. 1906. pp. 154-162. 5 Figs.

The species dealt with in this paper is not known, as Lieut. Tulloch states: "The dissections of the local variety of *Stomoxys*, which form the subject of this Note, were made at the suggestion of Prof. Minchin, during his direction of the Royal Society's Commission on Sleeping Sickness in Entebbe, Uganda. Lieutenant Tulloch describes the Digestive System, the Nervous System, the Circulatory System, and the ♂ and ♀ Generative Organs.

**Giles, G. M.** The Anatomy of the Biting Flies of the Genus *Stomoxys* and *Glossina*. Journ. Trop. Med. Lond. Vol. 9. 1906. pp. 99, 153, 169, 182, 198, 217, and 235. 1 Pl. and 36 Figs.

The parts dealing with the digestive tract, and the reproductive organs are taken mainly from Tulloch and Minchin, whose figures are reproduced.

**Stephens, J. W. W., and Newstead, R.** The Anatomy of the Proboscis of Biting Flies Ann. Trop. Med. & Parasitol. Liverpool, Vol. 1. 1907. pp. 171-198. 8 pls.

**Surcouf, J., and Picard, F.** Note sur les diptères du genre *Stomoxys* en Abyssinie Bull. Soc. Path. Exot., Par. Vol. 1, 1908. pp. 195-198.

This paper deals with the Genus *Stomoxys* in general but the following particulars are given on the mouth parts:

"Appareil buccal: L'appareil buccal est réduit; il se compose en dessus, d'un labre triangulaire, tranchant sur les bords et limitant une cavité où se trouve la langue ou hypopharynx, non piquante et percée d'un canal en son milieu.

"La lèvre inférieure, tranchante, faite en forme de gouge, pénètre dans les tissus et forme le dessous. Cette lèvre inférieure porte deux prolongements nommés paraglosses, qui sont hérissés de grosses épines tactiles. Elle porte les palpes près de sa base, et, au repos, sert à envelopper la langue."

## DESCRIPTION OF PLATES.

## PLATE XXXIII.

Figs. 1—9 after drawings by Terzi in Reports to Local Gov. Bd. on Public Health,  
N. S. No. 5. 1909. London.

- Fig. 1. *Musca domestica* Linn., perfect insect.
- Fig. 2. *Musca domestica* Larva.
- Fig. 3. *Musca domestica* Pupa.
- Fig. 4. *Homalomyia canicularis*, Linn., perfect insect.
- Fig. 5. *Homalomyia canicularis*, Larva.
- Fig. 6. *Homalomyia canicularis* Pupa.
- Fig. 7. *Stomoxys calcitrans* Linn., perfect insect.
- Fig. 8. *Stomoxys calcitrans* Larva.
- Fig. 9. *Stomoxys calcitrans* Pupa.

N. B.—All figures are 4 times natural size.

## PLATE XXXIV.

External mouth parts of *Stomoxys calcitrans* Linn.

- Fig. 1. Median longitudinal section of skeleton of front of head showing antennae, maxillary palpi and proboscis; v, vertex; ant., antenna; ar., arista; mxp., left maxillary palpus; ap., apodeme; pr., proboscis; I, II, III, segments of labium; III, showing left labellum.
- Fig. 2. Proboscis with labium removed; ap., apodeme; ph., pharynx; sd., salivary duct; g., lower part of oesophagus connecting the food canal of proboscis with the pharynx; I, portion of base of labium; lb., labrum; h. p., hypopharynx.
- Fig. 3. Transverse section of base of proboscis. I outer wall of base of Segment I of labium; m. c., muscle cells; lb., section of labrum; h. p., section of hypopharynx; fc., food canal formed by labrum and hypopharynx combined; s. c., salivary canal of hypopharynx; tr., trachea; k., keel of chitin which gives rigidity to the base of labial groove.
- Fig. 4. Base of proboscis with labium removed (adapted from Hansen's fig.); m., right muscle of enlargement of salivary duct s. d.; ph., pharynx; g., tube leading to pharynx; ap., base of apodeme; lb., labrum; h. p., hypopharynx; b. h. p., base of hypopharynx; k, part of keel; see Fig. 3.
- Fig. 5. Inner surface of right labellum; vw., ventral wall; d. m., dorsal margin; ct., chitinous teeth; cb., chitinous blades; h., hair-like processes (adapted from Hansen's fig.).